



Geant4 Physics for Fermilab Scientific Program

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SCD/FPE/ADSS/DSG

SCD Project Status Meeting
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Geant4 and Intensity Frontier Experiments



- There is a need to increase the emphasis in Geant4 on the physics relevant to Fermilab Intensity Frontier (IF) experiments.
- It is important to:
 - monitor and improve Geant4 simulation of relevant physics processes
 - monitor and influence the evolution and development Geant4 Physics Lists*
 - improve the existing Physics Lists documentation
 - * Geant4 Physics List is a named collection of particles, cross-sections and models (including their parameters) used to simulate physics processes



Goals



- Continuation of current periodic validation efforts (internal Geant4 tests)
 - intermediate and high energy hadronic interactions (~1-~150GeV) (hadron nuclear interactions)
 - stopping/capture processes
 - gamma nuclear interactions (~0.5GeV)
- Continuation of the support and evolution of the Geant4 Validation Repository
- Creation of a local Geant4 Physics List documentation
 - lists description, application and hints on modifications
- Creation of an infrastructure to monitor, enhance and develop Geant4 Physics Lists



Goals - cont'd



- Enhancement of our current Geant4 validation efforts
 - Extension of internal Geant4 tests in which we are currently involved (and therefore we can modify the code)
 - covering more processes important to the Intensity Frontier Experiments
 - including monitoring of relevant observables at the Geant4 Physics List level (as opposed to a process/model level)
 - Creation of a local <u>art</u> based Geant4 validation and test package (giving us more physics coverage freedom)
 - covering all processes and kinematic regions important to the Intensity Frontier Experiments not only at the process/model but also at Physics List level
 - facilitating customization and creation of new Physics Lists



More on Goals



- The Geant4 external validation package is going to be based on the locally developed/supported art framework further leveraging our department's expertise
 - it could be used as a template for new groups starting to use Geant4
- Locally developed tests and documentation would be fed back to the Geant4 Collaboration



Milestones (next few months)



- Documentation Improvements
 - Migration of the current local Geant4 web pages to a new SharePoint based website
 - Creation of documentation of relevant Geant4 Physics Lists and their aspects using the above website
 - Creation of a list of relevant physics processes and observables (and its prioritization)
 - Documentation of the data needed for the validation
 - as to, if it is preset (i.e. in use), available or not known to exist
- Enhancement of the internal Geant4 tests
 - restructuring/refactoring of the current tests
 - addition of a Physics Level test
- Creation of the *local* art based Geant4 validation package
 - the first step would be to implement a Physics List level test of selected observables



Current Activities/Status



- Internal Geant4 validation tests
 - a set of tests exists and is in use; for historical reasons, the tests predominantly used to cover observables and energy ranges of interest to LHC experiments
 - hadronic processes, intermediate energies
 - ~1GeV ~30GeV hadrons (mainly protons, pions) on C, U and other targets
 - hadronic processes, high energies
 - ≥ ~30GeV~150GeV hadrons (mainly protons, pions) on C and other targets
 - gamma-nuclear interactions
 - ~0.5GeV gammas on Cu, Pb
 - stopping/capture processes
 - they are standalone packages being run periodically (at CERN and locally) as a part of Geant4 Collaboration Hadronic Physics Group validation process
 - the results from the local tests are uploaded to the Validation Repository
 - the tests are being refactored and a test covering observables at the Physics List level is being added
 - new observables are being added with the focus on the Fermilab Experiments (e.g. muon stopping tests and more high energy hadronic distributions were added since last summer)

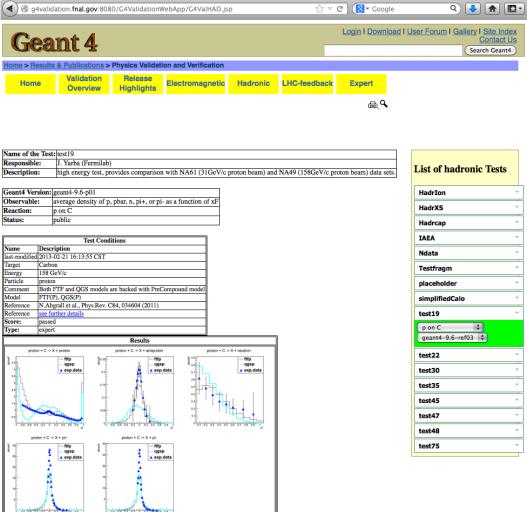


Current Activities/Status - cont'd



- Internal Geant4 validation tests
 - an example of test results uploaded to the Validation Repository

http://g4validation.fnal.gov: 8080/G4ValidationWebApp/ G4ValHAD.jsp test19 (Hadronic Processes, High Energy), protons on Carbon, 158GeV/c





Current Activities/Status - cont'd



- Interacting with the Experiments
 - Held a meeting (early March) with neutrino experiments to seek their input and establish communication channels
 - Participated in follow-up meetings
- Working on documentation
 - new local website was setup by SharePoint support group last week
 - the local Geant4 web pages are being migrated to it
- Working on improving and adding more flexibility to Geant4 muon stopping code

(with Kevin Lynch (CUNY/Mu2e) and people from Geant4 Hadronic Group)

- Initial restructuring was done by the original author last summer
- We have subsequently added additional configurability to the code
- We have submitted a correction pertaining to the bound muon capture and decay rate code (relevant to Mu2e) last month
 - it was included in the official Geant4 patch release (9.6.p02) last week
- External Geant4 validation package
 - at the design/prototyping stage



Future Plans



- Based on the validation tasks and feedback from the Fermilab community (and in response to the Geant4 developments)
 - continue ongoing testing of Geant4 releases documenting results in the Validation Repository
 - maintain and enhance the infrastructure and documentation
 - add more monitored observables and processes
 - collect data needed for validation
 - possibly suggest new test beam experiments
 - update Physics List documentation and their tests as the lists evolve
 - maintain and enhance the Validation Repository as needed
 - make or request Geant4 physics enhancements depending on which group is responsible for a given area of the code